

Estimates of Fish Populations in Two Northeastern North Carolina Swamp Streams

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ABSTRACT. — Fish populations were sampled in two northeastern North Carolina swamp streams, Duke and Hoggard Mill Creek, from May through August 1972. Water conditions permitted partitioning the streams into 0.4 km sections with nets, and estimating the abundances of 30 species in randomly chosen areas using the Petersen method. Some biomass estimates were also made. Population estimates in Duke Swamp varied from 6630 to 33,734 fish per surface hectare. In Hoggard Mill Creek estimated numbers ranged from 17,656 to 103,891 fish per surface hectare. Large variations were found in numbers of fish among sections of stream, but these variations were not uniform from species to species. Biomass estimates ranged from 195 kg to 1607 kg of fish per surface hectare for the two streams.

INTRODUCTION

Swamp streams are generally defined as streams located in lowland areas which flood periodically, inundating the vegetated flood plain for extended periods during the year. These areas are usually characterized by the presence of bald cypress, *Taxodium distichum*, and tupelo gum, *Nyssa aquatica*. The plant communities in these systems were described in detail by Wells (1928), Beaven and Oosting (1939), and Hall and Penfound (1943). Although swamp stream ecosystems are known to have diverse communities (Viosca 1928, Wharton 1970), few studies have been conducted regarding the abundance of their components.

Fish populations in two swamp streams were examined in this study from May through August 1972, in an effort to determine their composition and magnitude. Attempts were made to estimate the numerical abundance, and in some cases the biomass, of each species.

MATERIALS AND METHODS

THE STUDY AREA

Duke Swamp and Hoggard Mill Creek are swamp streams in northeastern North Carolina (Fig. 1). Timber has been logged along both

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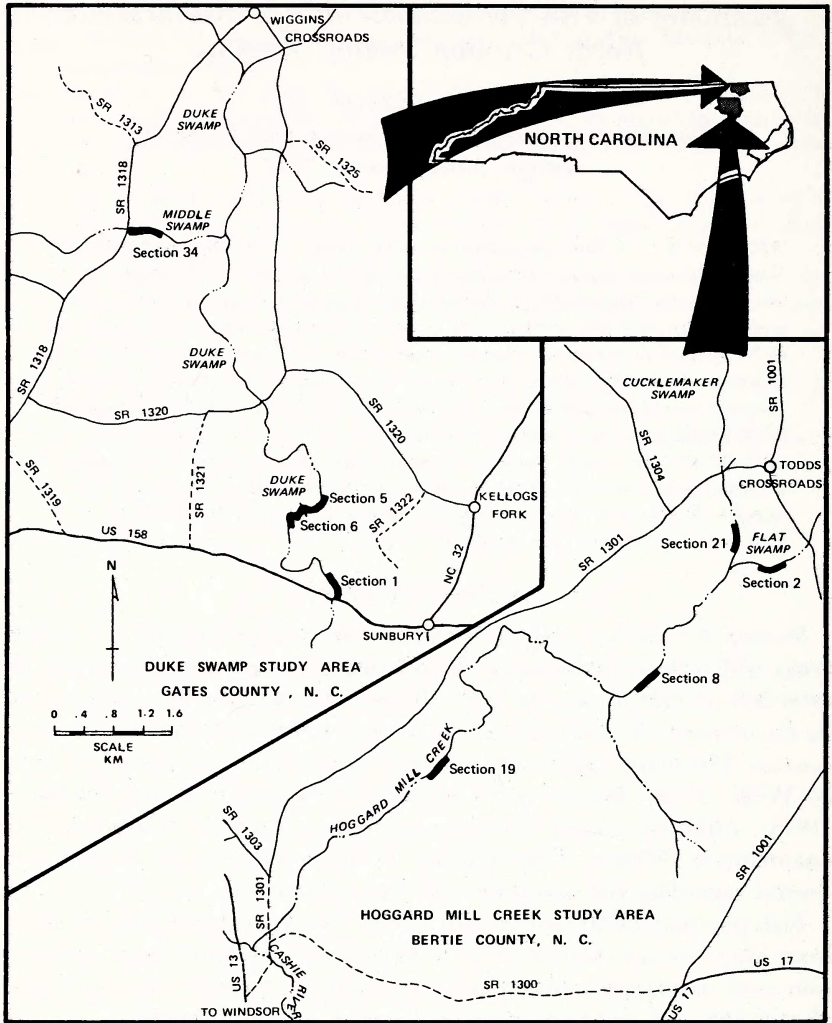


Fig. 1. Maps of Duke Swamp (upper left) and Hoggard Mill Creek (lower right) study areas, showing sampling sections.

streams but most areas have returned to the gum-cypress dominant forest type. In a few recently logged areas dense stands of aquatic vegetation and dense shrub layer have developed.

Approximately 13.7 stream km of Duke Swamp, a tributary to Lassiter Swamp and the Chowan River in eastern Gates County, were designated the Duke Swamp study area (Fig. 1). Hoggard Mill Creek, tributary to

Table 1. Fishes collected in Duke Swamp and Hoggard Mill Creek, May 1972 through August 1972 (P = Present). Names from Bailey et al. (1970).

Species	Duke Swamp	Hoggard Mill Creek
Bowfin, <i>Amia calva</i>	P	P
American eel, <i>Anguilla rostrata</i>	P	P
Eastern mudminnow, <i>Umbra pygmaea</i>	P	P
Redfin pickerel, <i>Esox americanus americanus</i>	P	P
Chain pickerel, <i>Esox niger</i>	P	P
Golden shiner, <i>Notemigonus crysoleucas</i>	P	P
Ironcolor shiner, <i>Notropis chalybaeus</i>		P
Unidentified shiner, <i>Notropis</i> sp.	P	
Creek chubsucker, <i>Erimyzon oblongus</i>	P	P
Yellow bullhead, <i>Ictalurus natalis</i>	P	P
Brown bullhead, <i>Ictalurus nebulosus</i>	P	P
Tadpole madtom, <i>Noturus gyrinus</i>	P	P
Swampfish, <i>Chologaster cornuta</i>	P	P
Pirate perch, <i>Aphredoderus sayanus</i>	P	P
Lined topminnow, <i>Fundulus lineolatus</i>	P	
Mosquitofish, <i>Gambusia affinis</i>	P	
Mud sunfish, <i>Acantharchus pomotis</i>	P	P
Flier, <i>Centrarchus macropterus</i>	P	P
Banded pigmy sunfish, <i>Elassoma zonatum</i>		P
Black banded sunfish, <i>Enneacanthus chaetodon</i>	P	
Bluespotted sunfish, <i>Enneacanthus gloriosus</i>	P	P
Banded sunfish, <i>Enneacanthus obesus</i>	P	
Redbreast sunfish, <i>Lepomis auritus</i>		P
Pumpkinseed, <i>Lepomis gibbosus</i>	P	P
Warmouth, <i>Lepomis gulosus</i>	P	P
Bluegill, <i>Lepomis macrochirus</i>	P	P
Largemouth bass, <i>Micropterus salmoides</i>	P	P
Black crappie, <i>Pomoxis nigromaculatus</i>	P	P
Swamp darter, <i>Etheostoma fusiforme</i>	P	
Sawcheek darter, <i>Etheostoma serriferum</i>		P
Yellow perch, <i>Perca flavescens</i>		P
	26	25

the Cashie River near its confluence with the Roanoke River, is located in Bertie County. The Hoggard Mill Creek study area extended approximately 9.3 stream km downstream from the Bertie County SR 1301 bridge on Cucklemaker Swamp and the SR 1001 bridge on Flat Swamp (Fig. 1). The main stream channels of both streams were measured and divided into 0.4 kilometer study sections.

Both streams varied considerably in size within the study area. Main stream channels were generally 2 to 8 m wide and a few cm to 6 m deep.

Table 2. Population estimates of fishes collected from Duke Swamp, May through August 1972. N = number of each species per surface hectare; CL = 80% confidence limits; B = biomass in kg per surface hectare; %N = percent of total number; %B = percent of total biomass; * = data not available or < 0.1 ; and ∞ = infinite.

Section 1					
Species	N	CL	B	%N	%B
Bowfin	22	(*.*)	8.3	.3	4.3
American eel	121	(62- ∞)	1.7	1.8	.9
Eastern mudminnow	7	(5- ∞)	.1	.1	.1
Redfin pickerel	1871	(1240-4549)	65.5	28.2	33.6
Chain pickerel	40	(*.*)	2.6	.6	1.3
Golden shiner	12	(*.*)	.1	.2	.1
Creek chubsucker	363	(255-1003)	13.1	5.5	6.7
Yellow bullhead	991	(541-18688)	35.6	14.9	18.2
Brown bullhead	99	(72- ∞)	4.8	1.5	2.5
Tadpole madtom	0				
Pirate perch	1082	(640-2031)	6.5	16.3	3.3
Mud sunfish	109	(54- ∞)	4.5	1.6	2.3
Flier	1174	(546- ∞)	41.0	17.7	21.0
Blackbanded sunfish	136	(72- ∞)	*	2.1	
Bluespotted sunfish	259	(126- ∞)	1.6	3.9	.8
Banded sunfish	0				
Pumpkinseed	2	(*.*)	*	.0	
Warmouth	79	(42- ∞)	7.1	1.2	3.6
Bluegill	217	(106- ∞)	2.6	3.3	1.3
Largemouth bass	10	(*.*)	*	.2	
Black crappie	10	(*.*)	*	.2	
Swamp darter	2	(*.*)	*	.0	
Sawcheek darter	22	(12- ∞)	*	.3	
TOTALS	6630		195.1		

The variation in volume of stream flow through a year had considerable influence on stream width due to the nearly uniform topography of the watersheds. Rises in stream level of approximately 1 m caused width increases of up to 0.8 km.

POPULATION ESTIMATES

Four study sections were randomly selected in each stream for fish population sampling. Sampling was conducted during summer low water periods using a combination of capture methods in an attempt to reduce bias from gear selectivity. Sections were blocked off with nets, and cylindrical poultry-wire traps, gill nets, a seine and a backpack Smith Root Type V electrofishing unit were used for collecting fish.

Table 2. (Continued)

Section 5					
Species	N	CL	B	%N	%B
Bowfin	25	(*-*)	9.2	.1	1.0
American eel	546	(309-10381)	7.6	1.6	.8
Eastern mudminnow ...	1300	(813-4653)	11.7	3.9	1.2
Redfin pickerel	7050	(4653-17238)	246.6	20.9	25.8
Chain pickerel	0				
Golden shiner	670	(321-∞)	6.1	2.0	.6
Creek chubsucker	11764	(6217-224102)	423.2	34.9	44.2
Yellow bullhead	4700	(2150-∞)	169.0	13.9	17.7
Brown bullhead	502	(250-∞)	24.5	1.5	2.6
Tadpole madtom	0				
Pirate perch	5916	(4465-9449)	35.4	17.5	3.7
Mud sunfish	7	(*-*)	*	.0	
Flier	546	(358-3010)	19.1	1.6	2.0
Blackbanded sunfish	7	(*-*)	*	.0	
Bluespotted sunfish	242	(119-∞)	1.5	.7	.2
Banded sunfish	0				
Pumpkinseed	148	(91-∞)	*	.4	
Warmouth	0				
Bluegill	247	(141-∞)	2.9	.7	.3
Largemouth bass	7	(*-*)	*	.0	
Black crappie	0				
Swamp darter	0				
Sawcheek darter	57	(40-∞)	.1	.2	.0
TOTALS	33734		956.9		

The Petersen single census mark-recapture method (Ricker 1958) was used in estimating populations. Sampling was divided into a marking period and a censusing period. A week generally was required for sampling each study section and at least one night separated the two periods. During the marking period all fish captured in good condition and large enough to mark (generally > 75 mm) were fin clipped and released. Fish too small to mark were counted and this count was considered a minimal population estimate. All fish (of the size marked) captured during censusing were inspected for marks. The same sampling effort was employed during the marking period and the censusing period.

An indication of fish biomass was obtained from the product of the numerical population estimates and the mean weight of a sample of fish (by species) collected from the study streams using the same collection techniques (Tarpsee 1975). In cases where the number of individuals considered in obtaining the mean weight was small, data from 1973 rotenone samples (Pardue et al. 1975) were also used.

Table 2. (Continued)

Section 6					
Species	N	CL	B	%N	%B
Bowfin	12	(*-*)	4.6	.1	1.6
American eel	82	(40-∞)	1.1	.8	.4
Eastern mudminnow ...	929	(425-∞)	8.3	8.9	2.6
Redfin pickerel	3039	(2078-6133)	106.3	29.3	36.5
Chain pickerel	27	(12-∞)	1.8	.3	.6
Golden shiner	237	(111-∞)	1.2	2.3	.4
Creek chubsucker	1391	(1048-1969)	50.0	13.4	17.2
Yellow bullhead	726	(484-2046)	26.1	7.0	9.0
Brown bullhead	178	(109-3403)	8.7	1.7	3.0
Tadpole madtom	2		*	.0	
Pirate perch	1285	(786-4623)	7.7	12.4	2.6
Mud sunfish	35	(20-∞)	1.5	.3	.5
Flier	1920	(1018-36934)	67.1	18.5	23.1
Blackbanded sunfish	0				
Bluespotted sunfish	131	(64-∞)	.8	1.3	.3
Banded sunfish	0				
Pumpkinseed	54	(30-∞)	*	.5	
Warmouth	25	(15-∞)	2.2	.2	.8
Bluegill	304	(163-∞)	3.7	2.9	1.3
Largemouth bass	0				
Black crappie	0				
Swamp darter	0				
Sawcheek darter	12	(*-*)	*	.1	
TOTALS	10389		291.1		

RESULTS AND DISCUSSION

The 27 species of fish collected from Duke Swamp and 24 species collected from Hoggard Mill Creek were typical of lowland blackwater streams (Table 1). Differences in the species lists can be largely attributed to those smaller species less susceptible to capture, and those represented by low numbers of individuals which may actually occur in both streams. Several additional species were reported from these areas by Pardue et al. (1975).

Population estimates of markable-size fish in the sampled sections of Duke Swamp and Hoggard Mill Creek are presented on a per hectare basis in Table 2 and 3. The area of water considered was only that contained within the main stream channel and did not reflect increases in surface area which occurred when water levels rose above the main channel banks.

The Petersen method is a single census technique, so confidence limits

Table 2. (Continued)

Species	Section 34				
	N	CL	B	%N	%B
Bowfin	74	(54-∞)	27.6	.4	5.0
American eel	334	(208-∞)	4.7	1.7	.9
Eastern mudminnow ...	801	(408-∞)	7.2	4.0	1.3
Redfin pickerel	5960	(5083-7440)	208.5	29.6	38.1
Chain pickerel	0				
Golden shiner	667	(566-927)	6.1	3.3	1.1
Creek chubsucker	79	(59-420)	2.8	.4	.5
Yellow bullhead	3121	(1433-∞)	112.2	15.5	20.5
Brown bullhead	1586	(882-30500)	77.7	7.9	14.2
Tadpole madtom	0				
Pirate perch	4159	(3425-5513)	24.9	20.6	4.5
Mud sunfish	35	(*-*)	1.5	.2	.3
Flier	1952	(1762-2271)	68.3	9.7	12.5
Blackbanded sunfish	0				
Bluespotted sunfish	326	(158-∞)	1.9	1.6	.3
Banded sunfish	1001	(549-18898)	*	5.0	
Pumpkinseed	17	(*-*)	*	.1	
Warmouth	49	(37-∞)	4.4	.2	.8
Bluegill	0				
Largemouth bass	0				
Black crappie	0				
Swamp darter	0				
Sawcheek darter	0				
TOTALS	20161		547.8		

were estimated by considering R (recaptures) as a binomial and using tables of confidence limits of binomial proportions (Mainland et al. 1956). The 80 percent level of confidence was selected for use in examining these estimates, as variability is often high in field studies of fish and wildlife populations and an 80 percent confidence level is often adequate for ecological evaluation and management.

There was considerable variation in numbers of fish between the sampled sections of Duke Swamp, with estimates ranging from 6630 fish weighing 195.1 kg per surface hectare to 33,734 fish weighing 956.9 kg (Table 2). Redfin pickerel, Yellow bullhead, Pirate perch and American eel, the most abundant fishes collected (pooled estimates), made up 69.0 percent of the estimated total. Large differences existed among species in the variation in population estimates between study sections. For example, Creek chubsucker estimates varied considerably between sections while Redfin pickerel were abundant in all sections.

Table 2. (Continued)

Species	Totals (Based on Pooled Data)				
	N	CL	B	%N	%B
Bowfin	17	(*.*)	6.2	.1	1.8
American eel	1433	(326-11937)	20.1	11.3	5.9
Eastern mudminnow ...	1065	(494-2911)	9.6	8.4	2.8
Redfin pickerel	2933	(2671-3487)	102.7	23.0	30.4
Chain pickerel	133	(40-1334)	8.5	1.0	2.5
Golden shiner	185	(143-250)	1.7	1.5	.5
Creek chubsucker	381	(346-423)	13.7	3.0	4.1
Yellow bullhead	2310	(1574-5866)	83.2	18.1	24.6
Brown bullhead	1035	(376-3571)	50.7	8.1	15.0
Tadpole madtom	2	(*.*)	.0	.0	.0
Pirate perch	2110	(1762-2553)	12.7	16.6	3.8
Mud sunfish	168	(43-1542)	6.9	1.3	2.0
Flier	554	(484-640)	19.4	4.4	5.7
Blackbanded sunfish	15	(*.*)	*	.1	
Bluespotted sunfish	49	(*.*)	.3	.4	.1
Banded sunfish	232	(59-2009)	*	1.8	
Pumpkinseed	17	(*.*)	*	.1	
Warmouth	20	(*.*)	1.7	.2	.5
Bluegill	49	(*.*)	.6	.4	.2
Largemouth bass	5	(*.*)	*	.0	
Black crappie	2	(*.*)	*	.0	
Swamp darter	2	(*.*)	*	.0	
Sawcheek darter	12	(*.*)	.0	.1	
TOTALS	12729		338.0		

Pirate perch, American eel, Yellow bullhead and Redfin pickerel were the most numerous species in Hoggard Mill Creek, making up 79.2 percent (pooled estimate) of the total (Table 3). Total estimates ranged from 17,656 to 103,891 fish per surface hectare and biomass estimates ranged from 218.8 kg to 1606.9 kg per surface hectare among the four sections sampled. The Pirate perch was the only species abundant in all sections. As in Duke Swamp there was considerable variation in the number of individuals of several species between study sections. Section 2, the section with the greatest fish density, primarily contained juvenile American eels, while Section 21 had a density of only 74 eels per surface hectare.

In Duke Swamp 70 percent of the estimated total fish biomass was made up of Redfin pickerel, Yellow bullhead and Brown bullhead. Most of the additional 30 percent was composed of American eel, Flier, Pirate Perch and Creek chubsucker. Six species—Yellow bullhead, Redfin pickerel, American eel, Pirate perch, Flier and Mud sunfish—composed

Table 3. Population estimates of fishes collected from Hoggard Mill Creek, May through August 1972. N = number of each species per surface hectare; CL = 80% confidence limits; B = biomass in kg per surface hectare; %N = percent of total number; %B = percent of total biomass; * = data not available or < 0.1; and ∞ = infinite.

Section 19					
Species	N	CL	B	%N	%B
Bowfin	10	(7- ∞)	3.7	.0	1.7
American eel	2780	(1619-15590)	38.9	13.2	17.8
Eastern mudminnow	22	(10- ∞)	.2	.1	.1
Redfin pickerel	526	(314-2936)	18.4	2.5	8.4
Chain pickerel	2	(*-*)	.1	.0	.0
Golden shiner	32	(20- ∞)	.2	.2	.1
Creek chubsucker	190	(131-670)	6.8	.9	3.1
Yellow bullhead	818	(430-15750)	29.4	3.9	13.4
Brown bullhead	2	(*-*)	.0	.0	.0
Tadpole madtom	1426	(660- ∞)	7.2	6.8	3.3
Pirate perch	12792	(9953-19217)	76.6	60.7	35.0
Mud sunfish	314	(151- ∞)	12.9	1.5	5.9
Flier	128	(67- ∞)	4.5	.6	2.1
Bluespotted sunfish	944	(442- ∞)	5.6	4.5	2.6
Redbreast sunfish	2	(*-*)	*	.0	
Pumpkinseed	7	(*-*)	*	.0	
Warmouth	146	(106- ∞)	13.0	.7	5.9
Bluegill	5	(*-*)	.1	.0	.0
Black crappie	5	(*-*)	*	.0	
Sawcheek darter	934	(423- ∞)	1.2	4.4	.5
Yellow perch	0		.0	.0	.0
TOTALS	21083		218.8		

92 percent of the estimated fish biomass in Hoggard Mill Creek. This comparison indicates that most of the biomass in both these streams is made up of species desired by fisherman.

The great variation in population estimates among the sections and between the streams sampled is probably primarily due to habitat difference. Some variation, however, may be due to changes in sampling gear efficiency in different stream types. The larger numbers of Pirate perch and American eel in Hoggard Mill creek may be related to the greater amount of aquatic vegetation in that stream. Section 2 of Hoggard Mill Creek contained dense beds of aquatic vegetation and a soft, muddy substrate. Densities of juvenile American eel and Pirate perch were much greater there than in any other sampling area in either stream.

In the larger sections of streams studied (Section 1 in Duke Swamp and part of Section 19 in Hoggard Mill Creek) some of the sampling gear, such

Table 3. (Continued)

Species	Section 8				
	N	CL	B	%N	%B
Bowfin	0		.0	.0	.0
American eel	1836	(1181-6541)	25.2	5.8	3.8
Eastern mudminnow ...	996	(492-∞)	9.0	3.2	1.4
Redfin pickerel	7144	(6061-9343)	249.9	22.6	37.6
Chain pickerel	5	(* - *)	.3	.0	.0
Golden shiner	133	(* - *)	1.0	.4	.2
Creek chubsucker	363	(232-2009)	13.1	1.2	2.0
Yellow bullhead	4223	(2644-15068)	126.9	13.4	19.1
Brown bullhead	0		.0	.0	.0
Tadpole madtom	1166	(549-∞)	5.8	3.7	.9
Pirate perch	9298	(7309-14435)	55.7	29.5	8.4
Mud sunfish	1866	(1223-5256)	78.9	5.9	11.9
Flier	2291	(1554-5542)	79.8	7.3	12.0
Bluespotted sunfish	2098	(951-∞)	12.6	6.7	1.9
Redbreast sunfish	5	(* - *)	*	.0	
Pumpkinseed	0			.0	
Warmouth	57	(* - *)	5.0	.2	.8
Bluegill	0		.0	.0	.0
Black crappie	0			.0	
Sawcheek darter	44	(27-∞)	.1	.1	.0
Yellow perch	22	(* - *)	.9	.1	.1
TOTALS	31547		664.2		

as the backpack electrofishing unit, became less effective and resulted in capture of fewer individuals and wider confidence limits.

This variation in fish population with habitat distribution appears to be a characteristic of these swamp systems. In this study we attempted to estimate the fish populations in the study area by using randomly chosen, relatively large sampling areas. The results provide a list of species found in these swamp streams, estimates of their abundance, and, perhaps most important, an indication of the variation found among areas within streams as well as between streams.

The number of fish collected that were too small to mark includes both species with a small adult size and juvenile fishes. These fish are included in the area species list (Table 1) and their numbers were reported by Tarplee (1975). Largest differences occurring between the two streams were in Swampfish and Ironcolor shiner, which were much more abundant in Hoggard Mill Creek than in Duke Swamp.

The estimates of fish biomass in both creeks are slightly higher than

Table 3. (Continued)

Species	Section 2				
	N	CL	B	%N	%B
Bowfin0		
American eel	37265	(23754-106347)	35.9	32.4	
Eastern mudminnow ...	18453	(8209-∞)	165.8	17.8	10.3
Redfin pickerel	11080	(6578-62012)	387.5	10.7	24.1
Chain pickerel	0		.0	.0	.0
Golden shiner	30	(17-∞)	.2	.0	
Creek chubsucker	0			.0	
Yellow bullhead	3877	(2323-21663)	139.1	3.7	8.7
Brown bullhead	0		.0	.0	.0
Tadpole madtom	173	(109-3274)	.9	.2	.1
Pirate perch	23951	(17880-37189)	143.5	23.1	8.9
Mud sunfish	536	(324-10232)	22.0	.5	1.4
Flier	2192	(1171-41752)	188.8	2.1	11.7
Bluespotted sunfish	6304	(2891-∞)	37.8	6.1	2.4
Redbreast sunfish	0			.0	
Pumpkinseed	0			.0	
Warmouth	0		.0	.0	.0
Bluegill	0		.0	.0	.0
Black crappie	0			.0	
Sawcheek darter	30	(17-∞)	.0	.0	.0
Yellow perch	0			.0	
TOTALS	103891		1606.9		

values reported for Louisiana backwater areas and rivers by Lantz (1970a, b), and within the range of values reported for the same Louisiana backwater area by Lambou (1959). These biomass estimates are also slightly higher on the average than fish populations reported from North Carolina swamp streams by Bayless and Smith (1963) and Tarplee et al. (1971), although most values in this study were within the range reported in the literature.

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Table 3. (Continued)

Species	Section 21				
	N	CL	B	%N	%B
Bowfin	0				
American eel	74	(44-∞)	1.0	.4	.3
Eastern mudminnow ...	3902	(3158-5389)	35.1	22.1	10.8
Redfin pickerel	5864	(4979-7386)	205.1	33.2	63.1
Chain pickerel	0		.0	.0	.0
Golden shiner	57	(* - *)	.4	.3	.1
Creek chubsucker	30	(* - *)	1.1	.2	.3
Yellow bullhead	1035	(591-∞)	37.2	5.9	11.4
Brown bullhead	0		.0	.0	.0
Tadpole madtom	0		.0	.0	.0
Pirate perch	6370	(4675-8634)	38.1	36.1	11.7
Mud sunfish	74	(59-1404)	3.0	.4	.9
Flier	74	(40-∞)	2.6	.4	.8
Bluespotted sunfish	166	(119-∞)	1.0	.9	.3
Redbreast sunfish	0			.0	
Pumpkinseed	0			.0	
Warmouth	5	(* - *)	.4	.0	.1
Bluegill	0			.0	.0
Black crappie	0			.0	
Sawcheek darter	5	(* - *)	.0	.0	.0
Yellow perch	0			.0	.0
TOTALS	17656		325.0		

LITERATURE CITED

- Bailey, Reeve M., J. E. Fitch, E. S. Herald, E. A. Lachner, C. C. Lindsey, C. R. Robins, and W. B. Scott. 1970. A list of common and scientific names of fishes from the United States and Canada. 3rd edition. Am. Fish. Soc. Spec. Publ. 6. 149 pp.
- Bayless, Jack, and W. B. Smith. 1965. The effects of channelization upon the fish populations of lotic waters in eastern North Carolina. N. C. Wildl. Resources Comm., Raleigh. 14 pp.
- Beaven, George F., and H. J. Oosting. 1939. Pocomoke Swamp: a study of a cypress swamp on the eastern shore of Maryland. Bull. Torrey Bot. Club 66:367-389.
- Hall, Thomas F., and W. T. Penfound. 1943. Cypress-gum communities in the Blue Girth Swamp near Selma, Alabama. Ecology 24:208-217.
- Lambou, Victor W. 1959. Fish populations of blackwater lakes in Louisiana. Trans. Am. Fish. Soc. 88:7-15.
- Lantz, Kenneth E. 1970a. An ecological survey of factors affecting fish production in a Louisiana backwater area and river. La. Wildl. Fish. Comm. Fish. Bull. 5. 60 pp.

Table 3. (Continued)

Species	Totals (Based on Pooled Data)				
	N	CL	B	%N	%B
Bowfin	2	(*.*)	1.3	.0	.2
American eel	8569	(5409-13838)	120.0	23.5	19.5
Eastern mudminnow ...	1940	(1483-2607)	17.5	5.3	2.8
Redfin pickerel	3973	(3482-4571)	139.1	10.9	22.6
Chain pickerel	2	(*.*)	.1	.0	.0
Golden shiner	133	(59-492)	1.2	.4	.2
Creek chubsucker	222	(136-408)	8.0	.6	1.3
Yellow bullhead	4265	(2340-761)	153.5	11.7	24.9
Brown bullhead	2	(*.*)	.1	.0	.0
Tadpole madtom	2797	(623-2238)	14.0	7.7	2.3
Pirate perch	12071	(10316-14201)	72.4	33.1	11.8
Mud sunfish	907	(521-1658)	37.1	2.5	6.0
Flier	1332	(825-2656)	46.6	3.6	7.6
Bluespotted sunfish	173	(*.*)	1.0	.5	.2
Redbreast sunfish	2	(*.*)	*	.0	
Pumpkinseed	5	(2-44)	*	.0	
Warmouth	47	(32-89)	4.1	.1	.7
Bluegill	2	(*.*)	.0	.0	.0
Black crappie	2	(*.*)	*	.0	
Sawcheek darter	59	(*.*)	.1	.2	.0
Yellow perch	2	(*.*)	.1	.1	.0
TOTALS	36507		616.1		

- 1970b. An ecological survey of factors affecting fish production in a Louisiana natural lake and river. La. Wildl. Fish. Comm. Fish. Bull. 6. 92 pp.
- Mainland, Donald, L., L. Herrera, and M. I. Sutcliffe. 1956. Tables for use with binomial samples. Dep. Med. Stat., N. Y. Univ. College Med., New York. 79 pp.
- Pardue, Garland B., M. T. Huish, and H. R. Perry, Jr. 1975. Ecological studies of two swamp watersheds in northeastern North Carolina—a prechannelization study. Water Resour. Res. Inst. Univ. N. C. Rep. No. 105, Raleigh. 455 pp.
- Ricker, William E. 1958. Handbook for computations for biological statistics of fish populations. Bull. 119. Fish. Res. Board Can. 300 pp.
- Tarplee, William H., Jr., D. E. Louder, and A. J. Weber. 1971. Evaluation of the effects of channelization on fish populations in North Carolina's coastal plain streams. Proc. 25th Annu. Conf. Southeast. Assoc. Game Fish Comm.:431-446.
- Tarplee, William H., Jr. 1975. Studies of the fish populations in two eastern North Carolina swamp streams. Master's thesis. North Carolina State Univ., Raleigh. 66 pp.

- Viosca, Percy, Jr. 1928. Louisiana wetlands and the value of their wildlife and fishery resource. *Ecology* 9:216-229.
- Wells, B. W. 1928. Plant communities of the coastal plain of North Carolina and their successional relations. *Ecology* 9:230-242.
- Wharton, Charles H. 1970. The southern river swamp—a multiple use environment. Bur. Business Econ. Res. Sch. Business Admin., Georgia State Univ., Atlanta. 45 pp.

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